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(58) Field of search
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(54) **"Non-contact measurement of speed and length"**

(57) To determine the speed and length of a continuously moving object such as a rod, strip, wire or cable 1 by means of an image recognition technique, or the recognition of another suitable characteristic of the object such as capacitance or inductance, the characteristic is measured at two spaced positions 2 and 3 in its path of travel and the correlation between the two measurement signals is determined. Given the distance D between the two positions and the time between the recognizable image or electrical characteristic of the object being identified at the two positions, the speed of movement of travelling object is determined. The length of the object is determined from the average of a plurality of speed measurements over a particular production run.

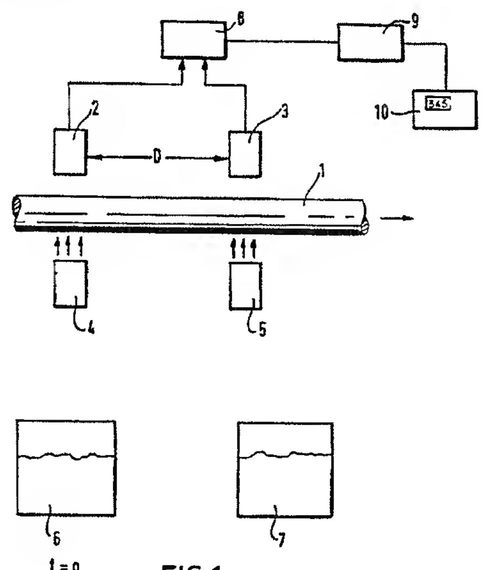

FIG.1.

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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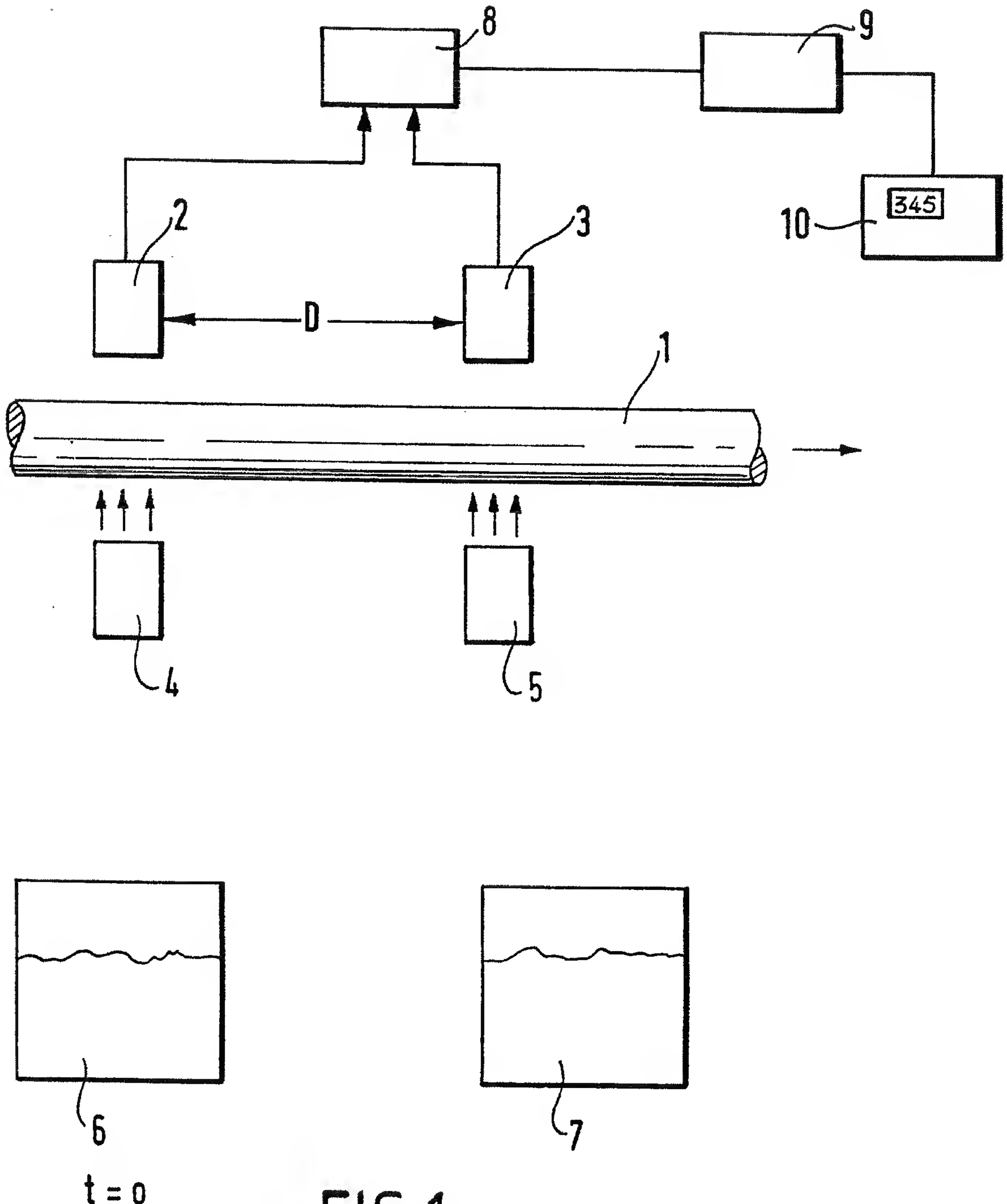

FIG. 1.

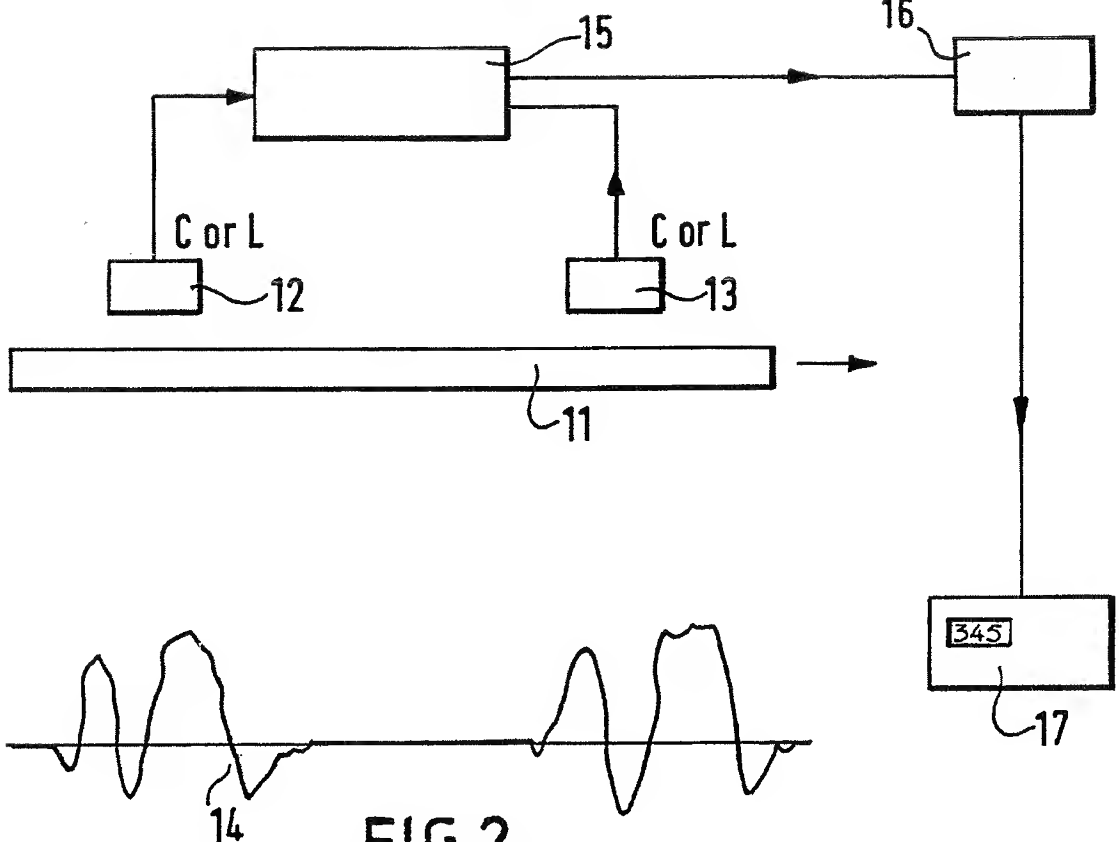

FIG.2.

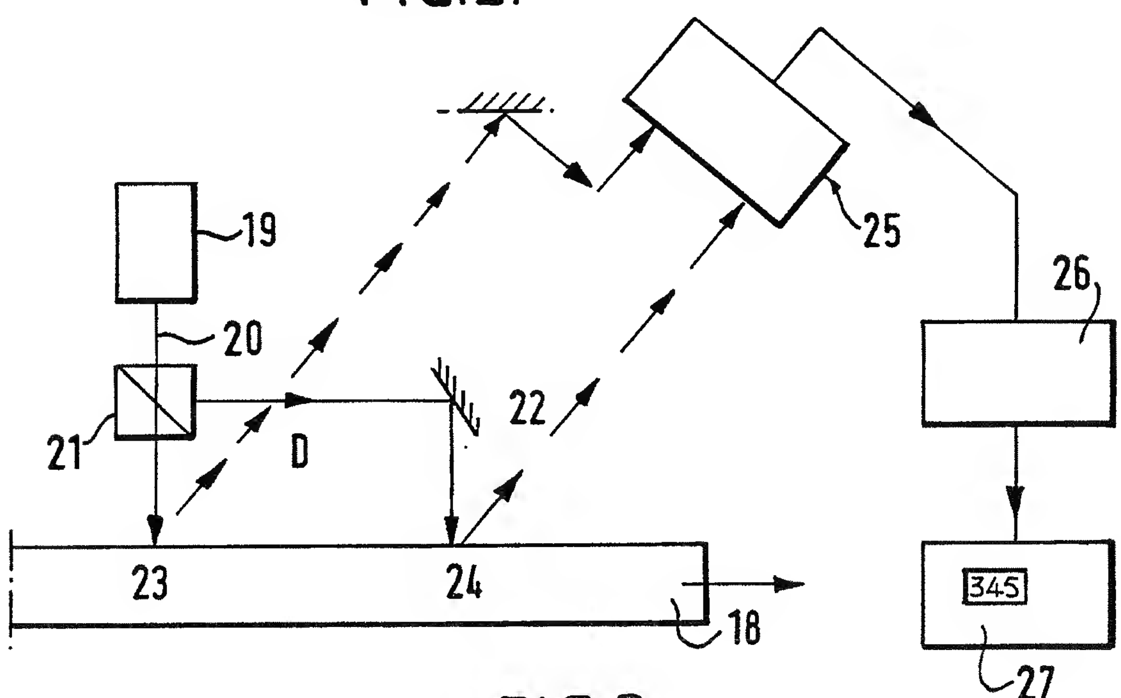

FIG.3.

"Non-Contact Measurement"

The invention relates to a method and apparatus for measuring the speed and length of a moving object by non-contact means.

It is desirable in certain industrial applications to measure the speed and diameter of a product under manufacture. Prior art teaches that there are various methods of achieving this, including by direct contact with the moving object or by optical means.

All of these prior techniques suffer from various disadvantages and limitations and this invention is directed to overcoming these deficiencies by providing method and apparatus for measuring the speed and length of a moving object by a recognition technique involving a particular characteristic of the object.

According to one aspect of the invention there is provided a non-contact method for determining the speed of a continuously moving object comprising identifying a characteristic representative of the object at a first position in its path of travel, identifying said characteristic as it reaches a second position in its path of travel a predetermined distance from said path of travel, calculating the time taken for said characteristic to move between said first and second positions and

dividing said distance moved by said time taken to determine the speed of movement of the object.

According to another aspect of the invention there is provided apparatus for determining the speed of a continuously moving object without contact therewith comprising first means for identifying a characteristic representative of the object at a first position in its path of travel, second means for identifying the said characteristic at a second position in the path of travel of said object a predetermined distance from said first position, and determining means, for determining the time taken between identification of said characteristic by said first and second means whereby to enable calculation of the speed of movement of said object equal to the ratio of said predetermined distance and said time taken.

Embodiments of the present invention will be described by reference to the accompanying drawings.

In Figure 1 an elongated object in the form of a bar, strip, cable and the like, is depicted moving along its own axis. Cameras 2 and 3 are positioned to look at the surface of the object 1, the surface being illuminated by light sources 4 and 5 emitting light in the direction of cameras 2 and 3 respectively with the object 1 in between. The surface of product 1 will contain small imperfections 6 observed by camera 2 and imperfections 7 observed by camera 3. Camera 2 observes the surface

6 at time $t_1 = 0$ and a signal of the picture of the surface 6 is transmitted to a pattern recognition circuit 8 which stores the picture. Camera 3 is then set up to receive surface pictures of product 1 and performs continuous recognition comparisons until such time as it recognises the same pattern as that recognised by camera 2 at time $t_1 = 0$.

Let us suppose that camera 3 recognises the surface pattern at later time t_2. Also let D be the distance along the path of the travelling object between cameras 2 and 3. The speed of the product will be given as $S = D/t_2 - t_1$ which would be the speed of the object at time t_2.

This measurement is then repeated many times per second and a table of results stored and an average of a preselected number of results are processed in the pattern recognition circuit 8 and fed to a processor 9. Processor 9 averages these results with respect to time, and an average product speed over a particular production run may then be derived. Knowing the overall time taken for a particular production run which can be predetermined it then becomes possible to determine the length of cable in that production run. Further since the average cross-sectional dimension of the object during the production run may be obtained by means not disclosed herein, the actual amount of material used in the production run may be calculated from the known length derived as above.

A similar method of measuring speed may be obtained by measuring the capacitance of the product moving in a linear direction. This method is generally limited to specific products including insulated cables or metal strips and would be suitable for underwater use. In Figure 2 a metal strip 11 is shown moving in a linear direction, and 12 and 13 are capacitive or inductive probes measuring the local capacitance or inductance of moving product 11. In a similar manner, 14 represents a wave form of the capacitance or inductance at the point of installation of probe 12 which is fed into a wave form recognition unit 15 which stores the wave form at initial time zero. Probe 13 then searches for that particular wave form and when this wave form passes probe 13, the time passage is measured. From the wave form recognition circuit 15, a computation is performed in unit 16 and the output is integrated and fed into unit 17 which similarly displays production length of product 11 and the speed of movement of the product 11.

A third method is disclosed in Figure 3. A moving object in the form of a flat or curved surface 18 is shown moving linearly, and a laser source of light 19 emits a narrow beam of light pointed at the moving surface of the object 18. The laser beam 20 is made to pass through a beam

splitter 21 which allows 50° of light to fall on object 18 and 50° light is reflected on to a mirror 22 which reflects the other 50° on to a moving surface 18 but at some distance D away from.the beam splitter.

The backscatter emitted from point 23 at which beam 20 impinges on the surface of product 18 is compared with backscatter 24 emitted from a second point at which the second half of the laser beam hits the product 18. The two beams are fed into an optical pattern recognition comparator 25 which compares the backscatter pattern received from 23 and 24. The comparator 25 memorizes an optical pattern emitted at point 23 at time zero and compares it with a pattern received from backscatter 24 some time later. Once again, by dividing time delay into distance from beam splitter 21 and mirror 22, a measure of the of object 18 is obtained and information is processed in processor 26 and then fed to indicator 27 to display the speed from which may be derived the overall length of cable processed in a particular production run.

CLAIMS

1. A non-contact method of determining the speed of a continuously moving object comprising

identifying a characteristic representative of the object at a first position in its path of travel,

identifying said characteristic as it reaches a second position in its path of travel a predetermined distance from said path of travel

calculating the time taken for said characteristic to move between said first and second positions and

dividing said distance moved by said time taken to determine the speed of movement of the object.

2. A method as claimed in claim 1 further comprising

providing a first response representative of said identified characteristic,

providing a succession of responses representative of a succession of differing characteristics of said object in advance of said identified characteristic,

comparing said first response with said succession of responses until a respective response in said succession of responses being the same as said first response, is identified, and

using said first and respective responses to determine the time taken for said identified characteristic to

move between said first and second positions

3. A method as claimed in claim 1 or 2 wherein said characteristic is an optical image representative of an identifiable surface configuration of the article.

4. A method as claimed in claims 1 or 2 wherein said chararcteristic is a capacitative or inductive value of said object obtained in waveform.

5. A method as claimed in claim 3 wherein a beam of laser light is directed at said object, splitting said beam such that a first split beam portion thereof illuminates said moving object at said first position, and a second split beam portion at said second position, observing an optical image representative of a particular surface configuration of said object present in said backscatter reflected from said object at said first position, searching the backscatter reflected from said object at said second position until an optical image representative of said particular surface portion is detected therein, and calculating the time taken between the respective observations of said optical image in the backscatter from said first and second positions of the object.

6. Apparatus for determining the speed of a

continuously moving object without contact therewith comprising first means for identifying a characteristic representative of the object at a first position in its path of travel, second means for identifying the said characteristic at a second position in the path of travel of said object a predetermined distance from said first position, and determining means for determining the time taken between identification of said characteristic by said first and second means whereby to enable calculation of the speed of movement of said object equal to the ratio of said predetermined distance and said time taken.

7. Apparatus as claimed in claim 6 wherein said first and second means are in the form of cameras, said determining means being a pattern recognition circuit which stores an image representative of a surface pattern of said object at said first position taken by one of said cameras for comparison with images received from the other said cameras until that other camera observes the same representative image, and including calculating means for calculating the time taken for recognition of said same representative image.

8. Apparatus as claimed in claim 6 wherein said first and second means are in the form of either capacitance

or inductance probes, said determining means being a wave form recognition circuit which stores a waveform representation of either capacitance or inductance of the object at said first position for comparison with capacitative or inductive waveform representations received from the object at said second position until the same representative waveform is obtained as that stored therein, and including calculating means for calculating the time taken for recognition of said same representative waveform in said recognition circuit.

9. Apparatus as claimed in claim 6 comprising a laser light source, a beam splitter for directing a portion of the beam of said laser light source to illuminate the object at said first position, and another portion of the beam to illuminate the object at said second position, means for storing an image representative of said characteristic in the form of a surface pattern of said object at said first position present in back-scatter laser light from said first position, said means including searching means for searching backscatter laser light from said second position until the said stored representative image is identified therein and calculating the time taken to identify the presence of said representative image in the backscatter from said second position.

10. A non-contact method of determining the speed of a continuously moving object substantially as hereinbefore described with reference to the drawings.

11. Apparatus for non-contact determination of the speed of a continuously moving object substantially as hereinbefore described with reference to the drawings.

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